



How to improve hospital infection control during COVID-19 pandemic? Operating room air pressure

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Abstract

With the emergence of the new COVID-19 pandemic healthcare systems around the world are facing an unprecedented strain and pressure. Along with the rapid adaptation of healthcare facilities and workforce to the huge number of patients requiring care and oxygen therapy, evidence-based data were gathered and rapidly published to continuously improve the patient's and healthcare system's management. With a growing number of cases, there is a high risk of in-hospital transmission of SARS-CoV-2 to other patients or healthcare staff. Pressure in hospital rooms plays an important role in the airborne transmission of diseases, including COVID-19. Negative pressure rooms are used for containing airborne pathogens within the defined space and positive pressure rooms are used to prevent the infection of highly susceptible patients (e.g operating theatres). Negative pressure operating rooms or several alternatives should be employed in the case of surgical COVID-19 patients as an additional safety measure, even though the risk of healthcare staff is low if protective personal equipment is used. The intubation and extubation of patients are high risk maneuvers of SARS-CoV-2 transmission and are also recommended to be performed in negative pressure environments.

Keywords: Covid-19, Negative pressure, Surgery, Operating Room

The emergence of the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and the following COVID-19 pandemic rocked the world during the last two years and dramatically changed almost all aspects of our life, resulting in a state of global public health emergency (1). On the 15th of October 2021, worldwide a total of 239.437.517 confirmed cases and 4.879.235 confirmed deaths of COVID-19 patients were reported (2). Healthcare systems around the world are facing an unprecedented strain and pressure. Along with the rapid adaptation of healthcare facilities and workforce to the

huge number of patients requiring care and oxygen therapy, evidence-based data were

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gathered and rapidly published to continuously improve the patient's and healthcare system's management. New challenges emerged in all medical fields, including operative care, along with the need to rapidly integrate new clinical information into daily medical practice (3, 4). Since hospitals housed an unprecedented number of SARS-CoV-2 infected patients the risk of in-hospital virus transmission to other patients and to healthcare personnel became a major concern of hospital infection control. A large number of policies preventing in-hospital virus transmission were rapidly applied, including protective equipment use, dedicated areas and circuits for infected patients, frequent personnel and patient testing, and others.

Since the pressure characteristic of any hospital room is an essential feature in controlling the transmission of various contaminants, but mainly airborne infections (5), room pressure regimens were rapidly adapted to the new context.

Negative pressure rooms have the main role of containing airborne pathogens within that space, avoiding the spread to the surrounding areas, and avoiding the infection of other susceptible individuals. Positive pressure rooms are used to prevent the infection of highly susceptible patients with airborne pathogens entering the room from the outside space.

The positive pressure rooms are usually regarded as the cleanest areas in a hospital and are useful in maintaining a clean/sterile environment avoiding contamination with potentially harmful pathogens, including viruses. The principle of positive pressure is that the air pressure in the room exceeds the outside pressure. This means that air can only exit the room and prevents outside infectious agents contaminating that hospital area. In this case, the antechamber, which receives the air

excess should have air filters and/or use ultraviolet irradiation for sterilization (3). Positive pressure rooms are commonly used for the isolation of immunocompromised patients, and operating theatres (3). Usually operating rooms benefit from one or both protective features: positive room pressure and/or a high number of filtered air conditioned cycles/hour.

Negative pressure rooms have lower air pressure than the outside environment.

The objective is containment of airborne contaminants, such as pathogens or chemicals within that space (3). Hospital areas that commonly use negative pressure are: waiting and triage areas in the Emergency Department, decontamination rooms, bathrooms, isolation rooms, autopsy rooms and storage areas. Negative pressure stations may be used in some laboratory (e.g. microbiology) or hospital pharmacy (e.g. chemotherapy drug preparation). This station is placed above the working station and directly draws air in a high-efficiency filtration system, avoiding exposure to hazardous substances or pathogens (3).

The reliability of a negative or positive pressurized chamber depends on efficient climate control systems and hospital construction aspects. These include a pressure monitor system, high efficiency air filters, adequate seal of the ventilation system, sealed windows, floors and walls and a system of fans that conduct the air in the suitable direction (3).

Early during the COVID-19 pandemic, the use of negative pressure for rooms and areas dedicated to infected patients was recommended to prevent cross-infection of patients and healthcare personnel. What about operating theaters, which are used for COVID-19 patient's surgery? Should they be converted from the

usual positive or zero room air pressure to a negative one due to the reasons mentioned above? COVID-19 patients with regional/local anesthesia, mainly if receiving supplemental oxygen or before/during endotracheal intubation, and after extubation may spread large amounts of viruses around.

The risk of airborne contamination of personnel in the operating theatre is considered to be low, especially if the staff is wearing personal protective equipment, but the use of negative pressure represents a supplemental safety measure. If the hospital ventilation system design allows it, the switch from positive or zero to negative room air pressure is recommended. If not, this can be achieved either by setting up portable high-efficiency filters and directing their exhaust tube in the return column of the ventilation system or by installing a negative pressure antechamber in the operating room (6).

But if these are not possible, how to lower the risk?

Taking into account that intubation and extubation are considered high risk maneuvers of SARS-CoV-2 transmission, it would be suitable to intubate/extubate the patient before/after transport to/from the operating room, especially if the patient is located in a negative pressure isolation room. If negative pressure rooms are not available on the ward, the patient may be intubated/extubated in the operating room. After completion of surgery and extubation, a period of 30 minutes should pass before transport in order to allow air turnover before opening the doors of the operating room. The in-hospital transport of COVID-19 patients should be made through specially designed circuits, and, if not intubated, the patient should wear a protective mask to prevent as much as possible virus transmission or droplet contamination.

In **conclusion**, the new SARS-CoV-2 pandemic mandates for new clinical data and healthcare system adjustments to be rapidly integrated into everyday practice of medicine. This is also the case of operative medicine. Air pressure in hospital rooms plays an important role in the prevention of transmission of COVID-19 disease to other patients or healthcare staff. Despite the fact that the risk of contamination is low, if personal protective equipment is used, negative pressure operating rooms are recommended for COVID-19 surgical patients as an additional safety measure and improved hospital infection control.

Conflict of Interest

Authors have no conflict of interest to disclose

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